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(54) **Ultrasonic pulse Doppler apparatus.**

(57) An ultrasonic pulse Doppler apparatus comprising an ultrasonic probe (14) for transmitting ultrasonic beam into an object and receives the echoes from the object, a first processing circuit (10a, 10c) for processing the echoes received by the probe (14) to form data of a B scan tomogram, a first monitor (13a) for displaying the B scan tomogram, beam mark setting circuit (11) for setting a plurality of beam marks (3a,...) on the B scan tomogram, measuring point setting circuit (12A) for setting a plurality of blood flow measuring points (2a,...) on each of the beam marks, beam mark selecting circuit (SW1) for selecting any one of the plurality of beam marks, measuring point selecting circuit (SW2 to SW10) for selecting any one of the plurality of blood flow measuring points on the selected beam mark, a second processing circuit (10b, 10d) for processing the echoes received by said probe (14) to form a signal of a blood flow velocity at the selected measuring point, a second monitor (13b) for displaying the blood flow velocity at the selected measuring point, and modulating circuit (12B) for distinguishing the selected measuring point on the selected beam mark from other measuring points.

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FIG. 3A

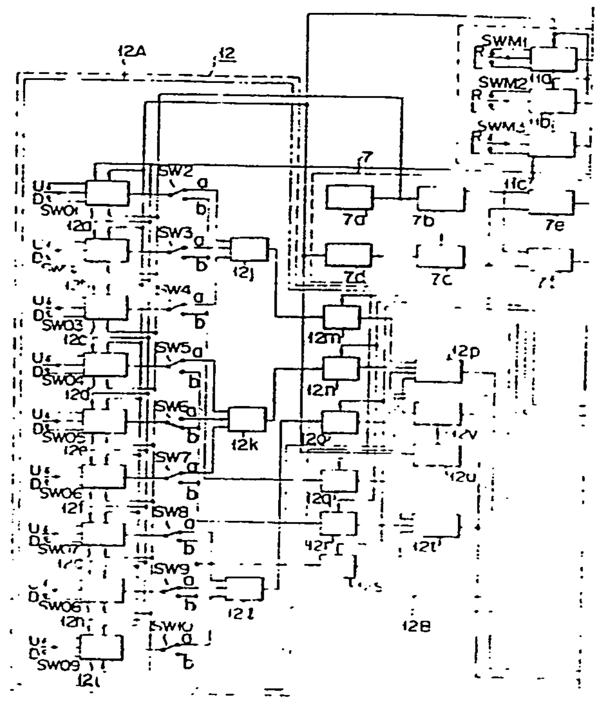
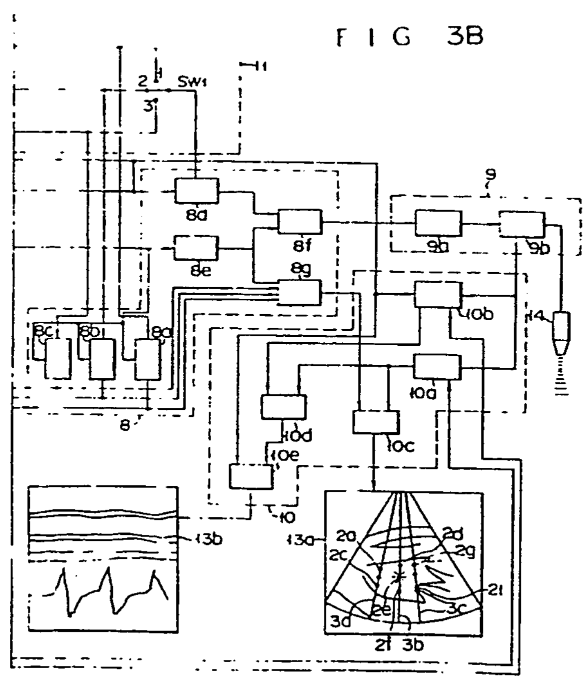


FIG 3B



Ultrasonic pulse doppler apparatus

The present invention relates to an ultrasonic pulse Doppler apparatus capable of displaying a tomogram on a specific part of an object under diagnosis, a plurality of ultrasonic beam marks, a plurality of blood flow measuring points, and a blood flow velocity signal at a specific measuring point selected from the plurality of measuring points on different monitor screens.

In a prior art ultrasonic pulse Doppler apparatus, a tomogram on a specific part of an object under diagnosis and a blood flow velocity signal at a specific point or a specific blood flow measuring point are displayed as shown in Fig. 1, for example. As shown, a monitor screen 1 displays a B mode tomogram formed by scanning the object in a sectorial fasion and a blood flow measuring point set on a beam mark 3. Another monitor screen 4 displays an M mode image representing a variation of a tissue along a beam mark 3 with time and a blood flow velocity signal 6 at the measuring point.

The Doppler frequency shift f_d is expressed by an equation $f_d = 2Vf_o \cos\theta/C$ where f_o is a frequency of a transmitted ultrasonic wave, V a blood flow velocity, C a velocity of the ultrasonic wave propagating in an object under diagnosis, and θ an angle of the ultrasonic beam with respect to a direction of blood flow. As seen from the equation describing a proportional relation between the Doppler frequency shift f_d and the

blood flow velocity, the blood flow can be obtained by detecting the Doppler frequency shift f_d.

The number of measuring points which can be set by the prior art Doppler apparatus is only one, as shown in Fig. 1. An accurate diagnosis, however, needs blood flow velocities measured quickly at a plurality of measuring points. For measuring blood flow velocities at different measuring points using the prior Doppler apparatus, the measuring point must be positioned again for each measurement of the blood flow velocity. Such positioning work of the measuring points takes a relatively long time. Thus, the prior art Doppler apparatus has not successfully satisfied such need.

Accordingly, an object of the present invention is to provide an ultrasonic pulse Doppler apparatus which may instantaneously and sequentially measure blood flow velocities at different positions by a simple operation.

According to the invention, there is provided an ultrasonic pulse Doppler apparatus comprising:

an ultrasonic probe for transmitting ultrasonic beam into an object and receives the echoes from said object;

a first processing means (10a, 10c) for processing the echoes received by said probe to form data of a B scan tomogram of said object;

a first display means for displaying the B scan tomogram;

beam mark setting means for setting at least one beam mark on the B scan tomogram;

measuring point setting means for setting a plurality of blood flow measuring points on said beam mark;

measuring point selecting means for selecting any one blood flow measuring point from said plurality of blood flow measuring points;

a second processing means for processing the echoes received by said probe to form a signal of a blood flow velocity at a selected measuring point;

a second display means for displaying the blood flow velocity at the selected measuring point; and

modulating means for distinguishing the selected measuring point on said beam mark from other measuring points on said beam mark.

According to the invention, there is further provided an ultrasonic pulse Doppler apparatus comprising:

an ultrasonic probe for transmitting ultrasonic beam into an object and receives the echoes from said object;

a first processing means for processing the echoes received by said probe to form data of a B mode tomogram of said object;

a first display means for displaying the B scan tomogram;

beam mark setting means (11) for setting a plurality of beam marks on the B scan tomogram;

measuring point setting means for setting a plurality of blood flow measuring points on each of said beam marks;

beam mark selecting means for selecting any one of said plurality of beam marks;

measuring point selecting means for selecting any one of said plurality of blood flow measuring points;

a second processing means for processing the echoes received by said probe to form a signal of a blood flow velocity at the selected measuring point;

a second display means for displaying the blood flow velocity at the selected measuring point; and

modulating means for distinguishing said selected measuring point on the selected beam mark from other measuring points.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 illustrates display modes displayed on

monitor screens of the prior ultrasonic pulse Doppler apparatus;

Fig. 2 illustrates display tomograms on monitor screens of a ultrasonic pulse Doppler apparatus according to the present invention;

Figs. 3A and 3B are schematic block diagrams of an arrangement of an ultrasonic pulse Doppler apparatus according to the present invention;

Fig. 4 is a block diagram of a signal generator used in the Doppler apparatus shown in Fig. 3A;

Fig. 5 is a block diagram of a scanning controller used in the Doppler apparatus shown in Fig. 3B;

Fig. 6 is a block diagram of an ultrasonic wave transmit/receive circuit used in the Doppler apparatus shown in Fig. 3B;

Fig. 7 is a block diagram of a display mode controller used in the Doppler apparatus shown in Fig. 3B;

Fig. 8 is a block diagram of a beam mark setting circuit used in the Doppler apparatus shown in Fig. 3A; and

Fig. 9 is a block diagram of a measuring point setting circuit used in the Doppler circuit shown in Fig. 3A.

An ultrasonic pulse Doppler apparatus according to the present invention is comprised of a signal generator 7, a scanning controller 8, a transducer controller 9, a display mode controller 10, a beam mark setting circuit 11, a measuring point setting circuit 12, two monitors 13a and 13b, and a sector scanning type ultrasonic transducer probe 14.

In the signal generator 7, a clock pulse generator 7a produces a clock pulse signal at 19.2 MHz, for example. A first frequency divider 7b frequency-divides the clock pulse signal from the generator 7a to produce a rate pulse signal at a given frequency, for example, 4 KHz. A second frequency divider 7c receives the rate

pulse signal from the frequency divider 7b to produce a pulse signal to define a rate of scanning for obtaining a B mode image signal, an M mode image signal and a blood flow velocity signal. A third frequency divider 7d frequency-divides the pulse signal from the second frequency divider 7c to form a pulse signal at such a frequency, for example, several Hz, so as to allow human eyes to visually follow the setting of beam marks 3a to 3c and blood flow measuring points 2a to 2i on a B mode image. A first gate circuit 7e converts the rate pulse signal from the first frequency divider 7b to a rate pulse signal for obtaining an M mode image and a blood flow velocity signal according to the pulse signal from the second frequency divider 7b. A second gate circuit 7f converts the rate pulse signal from the first frequency divider 7b into a rate pulse signal for obtaining a B mode according to the output pulse signal from the second frequency divider 7c. For setting to 1 : 1 a ratio of the scanning rates of the B mode image to the M mode image signals and the blood flow velocity signal, a dividing ratio of the second frequency divider 7c is set to 1/2.

The scanning controller 8 controls the scannings for forming the B mode image, the M mode image and the blood flow velocity signal. The scanning controller 8 is comprised of first to third scanning control circuits for beam marks 8a to 8c, a scanning control circuit 8d for the M mode image, another scanning control circuit 8e for the B mode image, a first adder 8f and a second adder 8g. The first to third scanning control circuits 8a to 8c encode the beam marks 3a to 3c set by setting circuits 11a to 11c in a beam mark setting circuit 11 (Fig. 8) and produce the coded signals in synchronism with the output pulse signal from the second gate circuit 7f. The scanning control circuit 8d produces one coded signal selected by a switch SW1 of the beam mark setting circuit 11, as an M mode control signal, in

synchronism with an output pulse signal from the first gate circuit 7e. The scanning control circuit 8e responds to a clock pulse signal from the second gate circuit 7f to alternately produce the coded signals corresponding to the individual scanning lines for forming a B mode image and the coded signals corresponding to the individual transducer elements of a probe 14. The first adder 8f adds together the coded signals produced from the scanning control circuit 8d and 8e. The second adder 8g adds together the coded signals produced from the scanning control circuits 8a to 8c and the scanning control circuit 8e.

The transducer controller 9 drives an array of the transducer elements of the probe 14 according to the coded signals produced from the first adder 8f of the scanning controller 8 to cause the probe 14 to project an ultrasonic wave toward the object under diagnosis. The transducer controller 9 receives the echoes of the ultrasonic wave returned from the object to convert them into electrical signals. The transducer controller 9 includes a transducer scanning circuit 9a and a transmit/receive (T/R) circuit 9b. The transducer scanning circuit 9a controls the operation of the transducer elements. The transmit/receive (T/R) circuit 9b generates a rate pulse signal according to an output signal from the scanning circuit 9a and drives the transducer elements of the probe 14 with the rate pulse signal applied, and further amplifies the signals of the echoes received by and applied from the probe 14.

The display mode controller 10 controls the display modes so that a B mode image is displayed on the monitor 13a, and an M mode image and a blood flow signal are displayed on the monitor 13b. The display mode controller 10 is comprised of a third adder 10a, a Doppler signal detecting circuit 10b, a B mode display control circuit 10, a fourth adder 10d, and an M mode image/blood flow velocity signal display control circuit 10e. The

third adder 10a adds an intensity modulation signal produced from a blood flow measuring point setting circuit 12 for setting three measuring points 2a to 2c, 2d to 2f and 2g to 2i on the beam marks 3a to 3c, as shown, and an echo signal produced from the T/R circuit 9b. The Doppler signal detecting circuit 10b detects a Doppler frequency shift at one selected measuring point of these points 2a to 2i, in synchronism with the M mode image scanning signal produced from the first gate circuit 7e in the signal generator 7. A B mode image display control circuit 10c receives a B mode image scanning signal from the second adder 8g in the scanning controller 8 and an intensity modulation signal from the third adder 10a to produce signals for displaying the B mode image (i.e. B scan tomogram), the beam marks, the blood flow measuring points on the monitor 13a. A fourth adder 10d adds a Doppler signal produced from the Doppler signal detecting circuit 10b and an M mode signal produced from the third adder 10. The M mode/blood flow velocity signal display control circuit receives an output signal from the first gate circuit 7e and an output signal from the fourth adder 10d to produce signals for displaying the M mode image and the blood flow velocity signal on the monitor 13b.

The beam mark setting circuit 11 determines positions of the monitor 13a. The beam mark setting circuit 11 is comprised of switches SWH1 to SWH3, first to third beam mark setting circuits 11a to 11c, and a switch SW1. The switches SWM1 to SWM3 horizontally move and desirably position the beam marks 3a to 3c on a B mode image displayed on a monitor 13a. The first to third beam mark setting circuits 11a to 11c produce signals indicating the beam marks 3a to 3c positioned by means of the swigches SWM1 to SWM3, respectively. The switch SW1 selects any of these output signals from the beam mark setting circuits 11a to 11c and sends it to the

scanning control circuit 8d.

The blood flow measuring point setting circuit 12 is comprised of a blood flow measuring unit 12A and a blood flow measuring select unit 12B, as shown in Fig. 9. The measuring point setting unit 12A positions the blood flow measuring points 2a to 2c, 2d to 2f, and 2g to 2i on the beam marks 3a to 3c displayed on the B mode image monitor 13a. The measuring point select unit 12B selects any one of the measuring points 2a to 2i to display a blood flow velocity at the selected measuring point on the monitor 13b. The blood flow measuring points 2a to 2i are more intensively displayed and particularly the selected measuring point 2e on the monitor 13a in Fig. 3B is flickered to distinctly indicate the measuring point of which the flood flow velocity signal is now displayed on the monitor 13b.

In the measuring point setting circuit 12A, nine switches SW01 to SW09 vertically move and desirably position the measuring points 2a to 2i on the monitor 13a. First to ninth measuring point setting circuits 12a to 12i produce signals representing measuring points positioned by means of the switches SW01 to SW09 in synchronism with a pulse signal from the third frequency divider 7d of the signal generator 7. Switches SW2 to SW4, which are respectively coupled with the measuring point setting circuits 12a to 12c, selectively switch the output signals from the measuring point setting circuits 12a to 12c to a fifth adder 12 or to a 6th gate circuit 12g. Switches SW5 to SW7, which are respectively coupled with the setting circuits 12d to 12f, selectively switch the output signals from the measuring point setting circuits 12d to 12f to a 6th adder 12k or to a 7th gate circuit 12r of the measuring point select unit 12B. Switches SW8 to SW10, which are respectively coupled with the measuring point setting circuts 12g to 12i, selectively switch the output signals from the measuring point setting circuits 12g to 12i to a 7th

adder 12ℓ or to an 8th gate circuit 12s of the measuring point select unit 12B. The 5th adder 12j adds together the output signals from the measuring point setting circuits 12a to 12c. The 6th adder 12k adds together the output signals from the measuring point setting circuits 12d to 12f. The 7th adder 12ℓ adds together the output signals from the measuring point setting circuits 12g to 12i. A 3rd gate circuit 12m produces the output signal (position signal) from the 5th adder 12j in synchronism with the output signal fro scanning the first beam mark 3a from the first scanning control circuit 8a for the first beam mark 3a. A 4th gate circuit 12n produces an output signal (position signal) from the 6th adder 12k in synchronism with an output signal for scanning the second beam mark 3b from the second scanning control circuit 8b for the second beam mark 3b. A gate circuit 12n produces an output signal for scanning the second beam mark 3b from the second scanning control circuit for the second beam mark 3b. A 5th gate circuit 12P produces an output signal (position signal) for scanning the 3rd beam mark from the 7th adder 12ℓ in synchronism with the output signal from the 3rd scanning control circuit 8c for the 3rd beam mark 3c. An 8th adder 12p adds the output signals from the gate circuits 12m, 12n and 12o. The output signal from the 8th adder 12p is applied as a signal for providing dots of the blood flow measuring points on the monitor screen, to the 3rd adder 10a of the display mode controller 10.

The measuring point select unit 12B is comprised of a 6th gate circuit 12q, a 7th gate circuit 12r, an 8th gate circuit 12s, a 9th adder 12t, and a modulation circuit 12p. The 6th gate circuit 12q produces output signals (position signals) from the setting circuits 12a to 12c in synchronism with an output signal (scanning signal) from the first scanning control circuit 8a. The 7th gate circuit 12r produces output signals (position signals) from the setting circuits 12d to 12f in

synchronism with the output signal (scanning signal) from the scanning control circuit 8b. The 8th gate circuit 12s produces output signals (position signals) from the measuring point setting circuits 12g to 12i in synchronism with the output signal (scanning signal) from the 3rd scanning control circuit 8c. The 9th adder 12t sums the output signals from the gate circuits 12q, 12r and 12s. The fourth frequency divider 12u frequency-divides the pulse signal from the 3rd divider 7d into a pulse signal at frequency less than several Hz. A modulation circuit 12p modulates an output signal indicating a blood flow measuring point to be selected, which is derived from the 9th adder 12t by an output pulse signal from the 4th divider 12u into a signal changing between two potential levels.

The switches SW2 to SW10 operate interlocking with one another and the switch SW1 in the measuring point setting circuit 11. When the switch SW6 is switched to the contacts "b", as shown in Fig. 9, the remaining switches SW2 to SW5 and SW7 to SW10 are connected to the contacts "a". At this time, the switch SW1 is connected to the contact "b". When the switch SW2 is connected to the contact "b", the other switches SW3 to SW10 are connected to the contacts "a" and the switch SW1 is connected to the contact "a". When the switch SW10 is connected to the contact "b", the other switches SW2 to SW9 are connected to the contacts "a" and the switch SW1 is connected to the contact "c".

The operation of the ultrasonic pulse Doppler apparatus shown in Fig. 3A to Fig. 9 will be described.

The power source (not shown) is turned on to operate the signal generator 7. Then, the signal generator 7 produces necessary pulse signals for transmission to the scanning controller 8, the display mode controller 10 and the blood flow velocity measuring point setting circuit 11. An output signal from the first adder 8f of the scanning controller 8 is applied

to the transducer controller 9 to drive the probe 14. The probe 14 driven projects an ultrasonic beam into an object under diagnosis in a sectorial scanning manner. The probe 14 converts the echo signals from the object into electrical signals. The electrical signal is amplified by the T/R circuit 9b is inputted to the 3rd adder 10a of the display mode controller 10. The display mode controller 10 receives signals indicating the measuring points 2a to 2i from the 8th adder 12p in the measuring point setting circuit 12, a B mode image signal containing the output signals representing positions of the beam marks 3a to 3c derived from the second adder 8g of the scanning controller 8, and the echo signal from the transducer controller 9. Upon receipt of these signals, the display mode controller 10 operates to display a B mode image, beam marks 3a to 3c, and blood flow velocity measuring points 2a to 2i on the monitor 13a.

A case where an M mode image and a blood flow velocity signal at a desired measuring point are displayed on the monitor 13b, will now be described. For selecting the blood flow velocity measuring point 2e on the beam mark 3b, the second beam mark 3b is horizontally moved by means of the switch SWM1 to set the same mark to a desired position on the monitor screen 13a, while visually observing the second beam mark 3b on the monitor screen 13a. Then, the switch SW6 is set to the contact "a". Under this condition, the switch SW05 is operated to vertically move the measuring point 2e selected along the beam mark 3b to a desired position.

Subsequently, the switch SW6 is switched to the contact "b". At this time, the switch SW1 is switched to the contact "b" interlocking with the operation of the switch SW6. And the other switches SW2 to SW5 and SW7 to SW10 are fixed at the contacts "a". As the result of switching of the contact "b" to the switch SW1, the second beam mark 3b is selected as a beam mark

on which the measuring point 2e to be selected lies. Upon switching the switch SW6 to the contact "b", the position signal set by the measuring point setting circuit 12e is applied, as a signal indicating the selected blood flow measuring point, through the 7th gate circuit 12r and the 9th adder 12t to the Doppler signal detecting circut 10b. In the Doppler signal detecting circuit 10b, the Doppler signal is extracted from the echo signal produced from the T/R circuit 9b by the signal indicating an output signal for indicating the selected measuring point derived from the 9th adder 12t. Further, the Doppler signal is produced in synchronism with the M mode image scanning signal from the first gate circuit 7e. The output Doppler signal is added to the M mode image signal from the 3rd adder 10a in the 4th adder 10d. The added signal is applied to the M mode image display control circuit 10e. The control circuit 10e is supplied with an output signal as an M mode rate pulse signal from the first gate circuit 7e. On the basis of these signals, the display control circuit 10e produces the M mode image scanning signal, the Doppler signal and the M mode image signal. These output signals from the display control circuit 10e is applied to the monitor 13b. Then, the monitor 13b displays the M mode and the blood flow velocity at the selected measuring point 2e.

The output signal for indicating the selected measuring point derived from the 9th adder 12t in the measuring point 12B is inputted to the modulation circuit 12v. In the modulation circuit 12v, it is modulated by the output pulse signal from the 4th frequency divider 12u into a voltage signal changing between two levels. The modulated signal is applied to the 8th adder 12p. The 8th adder 12p adds together the output signals from the 3rd to 5th gate circuits 12m, 12n and 12o. The signal representing the addition is applied to the 3rd adder 10a of the display mode controller 10a.

As a result, on the monitor 13a, only the measuring point 2e flickers. Seeing the flickering of the measuring point, an observer knows that the blood flow velocity is measured at the measuring point 2e now flickering on the monitor 13b.

In switching the selected measuring point 2e to another measuring point 2a, for example, for displaying the blood flow velocity signal at the measuring point 2e on the monitor 13b, all the observer has to do is to switch the switch SW2 in the measuring point setting unit 12A to the contact "b". Through the circuit operation similar to that described relating to the measuring point 2e, the monitor 13a displays the blood flow velocity signal at the measuring point 2a on the monitor 13b and the M mode image at the beam mark 3a bearing the measuring point 2a are displayed, while the measuring point 2a flickers on the monitor 13a.

As described above, in the ultrasonic pulse Doppler apparatus, a tomogram at a part to be observed is displayed on one display screen. At the same time, a blood flow velocity is dislayed in a manner that a plurality of blood flow velocity measuring points are set on and along the beam marks, and one desired measuring point is selected from those measuring points by a simple switching operation, while observing the tomogram. Thus, since the selecting operation is simple, time taken from the select operation to the display of the blood flow signal on the other monitor is relatively short. No deterioration of the reliability of the blood flow velocity measurement arises from time delay. Further, the selected measuring point can be changed by one time switching operation, the blood flow velocities at a plurality of measuring points can be displayed at short time intervals. The flickering of the selected measuring point enables an observer to clearly know the correspondence of a blood flow velocity signal displayed on one monitor and the selected

measuring point. Thus, the Doppler apparatus according to the present invention provide a highly reliable diagnosis data.

It shoud be understood that the present invention is not limited by the above-mentioned embodiment, but may variously be modified and changed. For example, the number of beam marks and the measuring points may be suitably selected. The filckering display of the selected measuring point may be substituted by any other suitable display such as an enlarged dot or a shape changing dot.

Claims:

1. An ultrasonic pulse Doppler apparatus having an ultrasonic probe (14) for transmitting ultrasonic beam into an object and receives the echoes from said object, a first processing means (10a, 10c) for processing the echoes received by said probe (14) to form data of a B scan tomogram of said object; a first display means (13a) for displaying the B scan tomogram; beam mark setting means (11), blood flow measuring point setting means (12A), a second processing means (10b, 10d) for processing the echoes received by said probe (14) to form a signal of a blood flow velocity at a measuring point, and a second display means (13b) for displaying the blood flow velocity at the measuring point, characterized in that said beam mark setting means (11) sets at least one beam mark on the B scan tomogram, and said measuring point setting means (12A) sets a plurality of blood flow measuring points on said beam mark, and characterized by further including measuring point selecting means (SW2 to SW10) for selecting any one of said plurality of blood flow measuring points, and modulating means (12B) for distinguishing said selected measuring point on said beam mark from other measuring points on said beam mark.

2. An ultrasonic pulse Doppler apparatus having an ultrasonic probe (14) for transmitting ultrasonic beam into an object and receives the echoes from said object, a first processing means (10a, 10c) for processing the echoes received by said probe (14) to form data of a B scan tomogram, a first display means (13a) for displaying the B scan tomogram, beam mark setting means (11), blood flow measuring point setting means (12A), a second processing means (10b, 10d) for processing the echoes received by said probe (14) to form a signal of a blood flow velocity at a measuring point, and a second display means (13b) for displaying

the blood flow velocity at the measuring point, characterized in that said beam mark setting means (11) for setting a plurality of beam marks on the B scan tomogram, said measuring point setting means (12A) for setting a plurality of blood flow measuring points on each of said beam marks, and characterized by further including beam mark selecting means (SW1) for selecting any one blood flow measuring point from said plurality of beam marks, measuring point selecting means (SW2 to SW10) for selecting any one of said plurality of blood flow measuring points, and modulating means (12B) for distinguishing said selected measuring point on the selected beam mark from other measuring points.

3. An ultrasonic pulse Doppler apparatus according to claim 2, characterized in that said measuring point selecting means (SW2 to SW10) interlocks with said beam mark selecting means (SW1) so that said measuring point selecting means (SW2 to SW10) operates to select a blood flow measuring point when said beam mark selecting means (SW1) operates to select a beam mark on which the selected measuring point exists.

FIG. 1

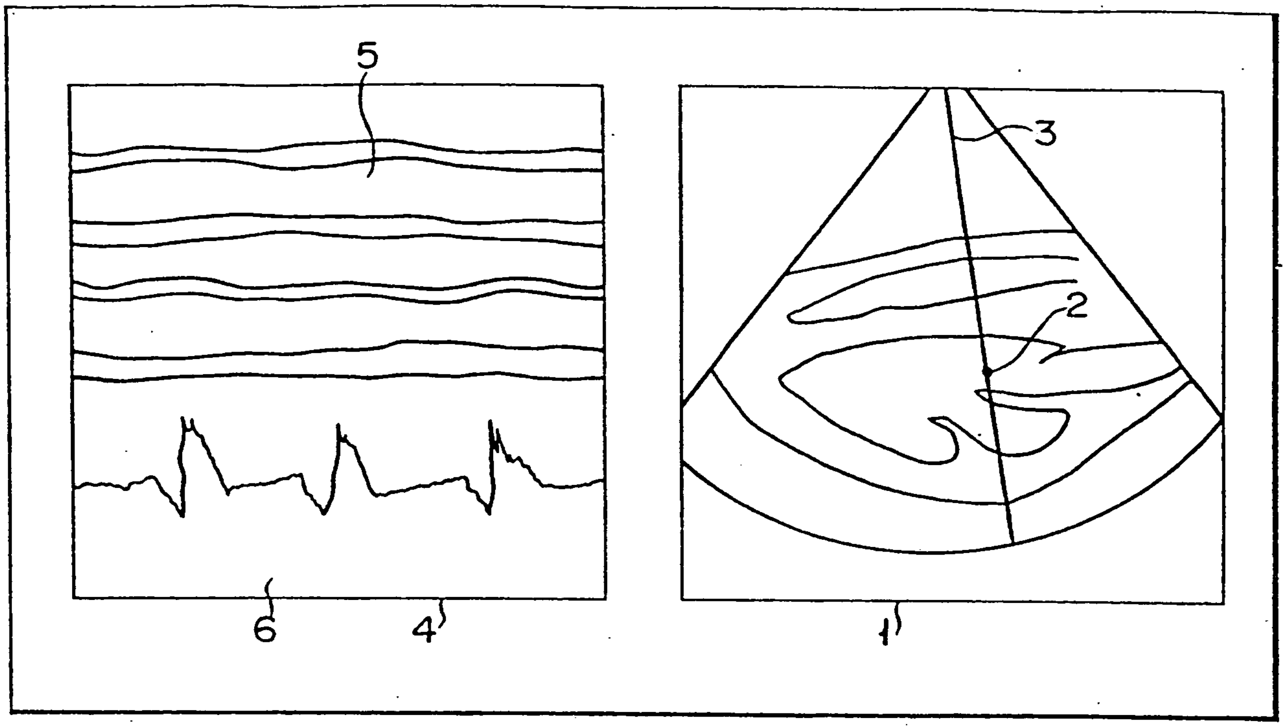


FIG. 2

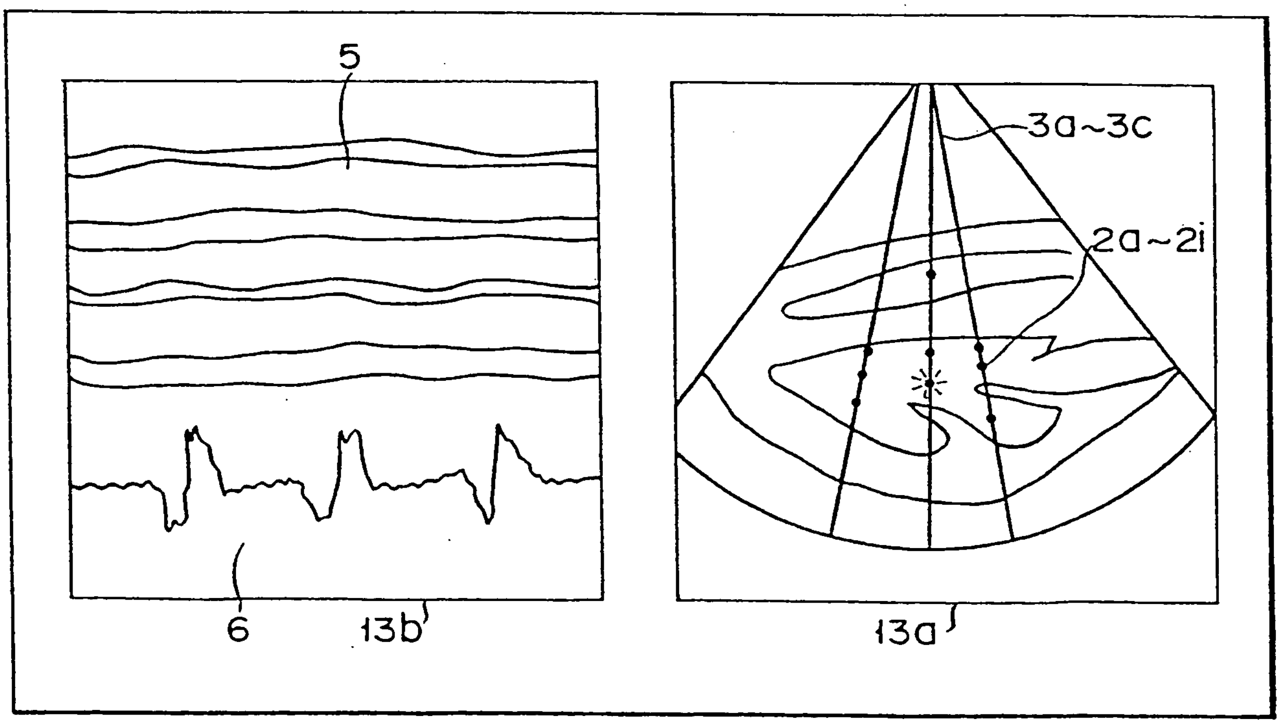
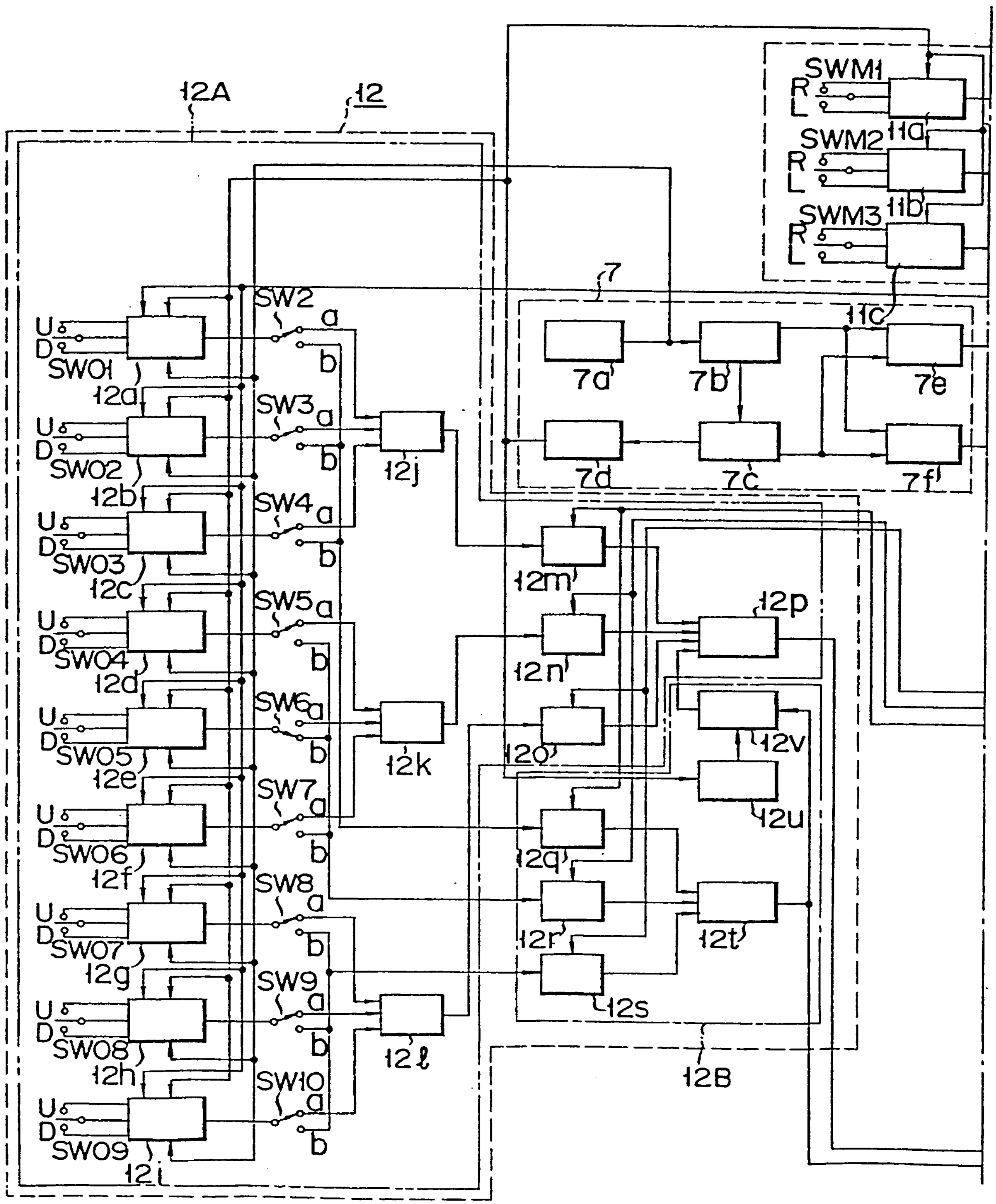


FIG. 3A


12A
12
SWM1
R
L
11a
SWM2
R
L
11b
SWM3
R
L
11c
7
7a
7b
7e
7d
7c
7f
SW2
a
b
SW3
a
b
SW4
a
b
SW5
a
b
SW6
a
b
SW7
a
b
SW8
a
b
SW9
a
b
SW10
a
b
U
D
SW01
12a
SW02
12b
SW03
12c
SW04
12d
SW05
12e
SW06
12f
SW07
12g
SW08
12h
SW09
12i
12j
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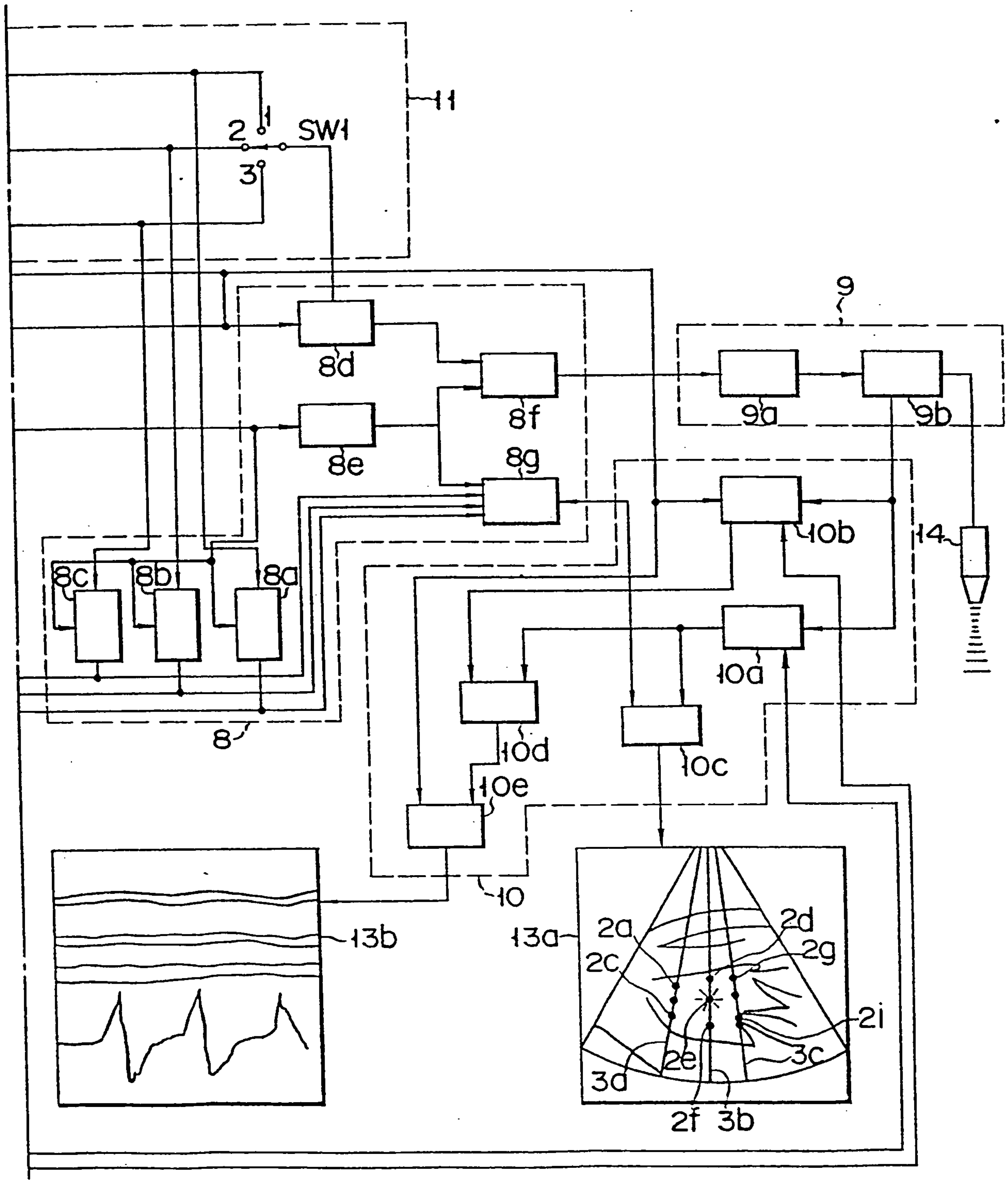
12v
12B

F I G. 3B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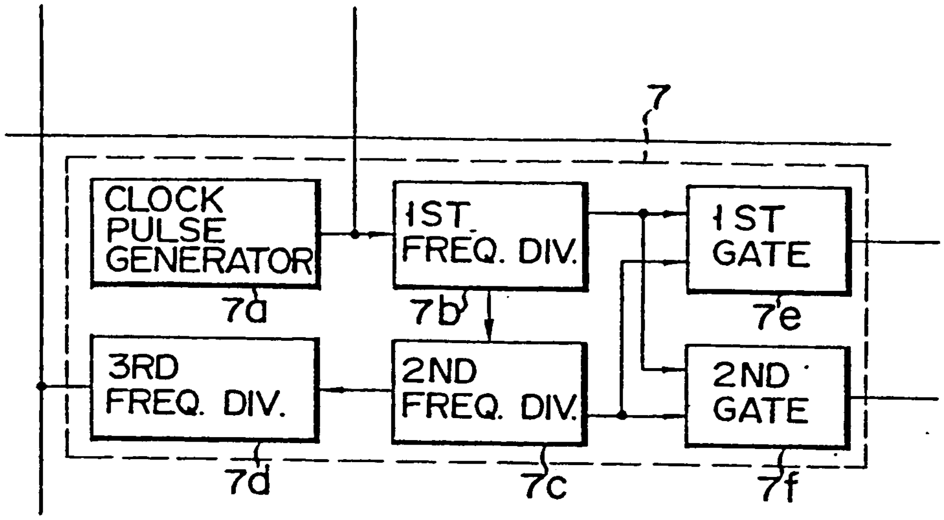
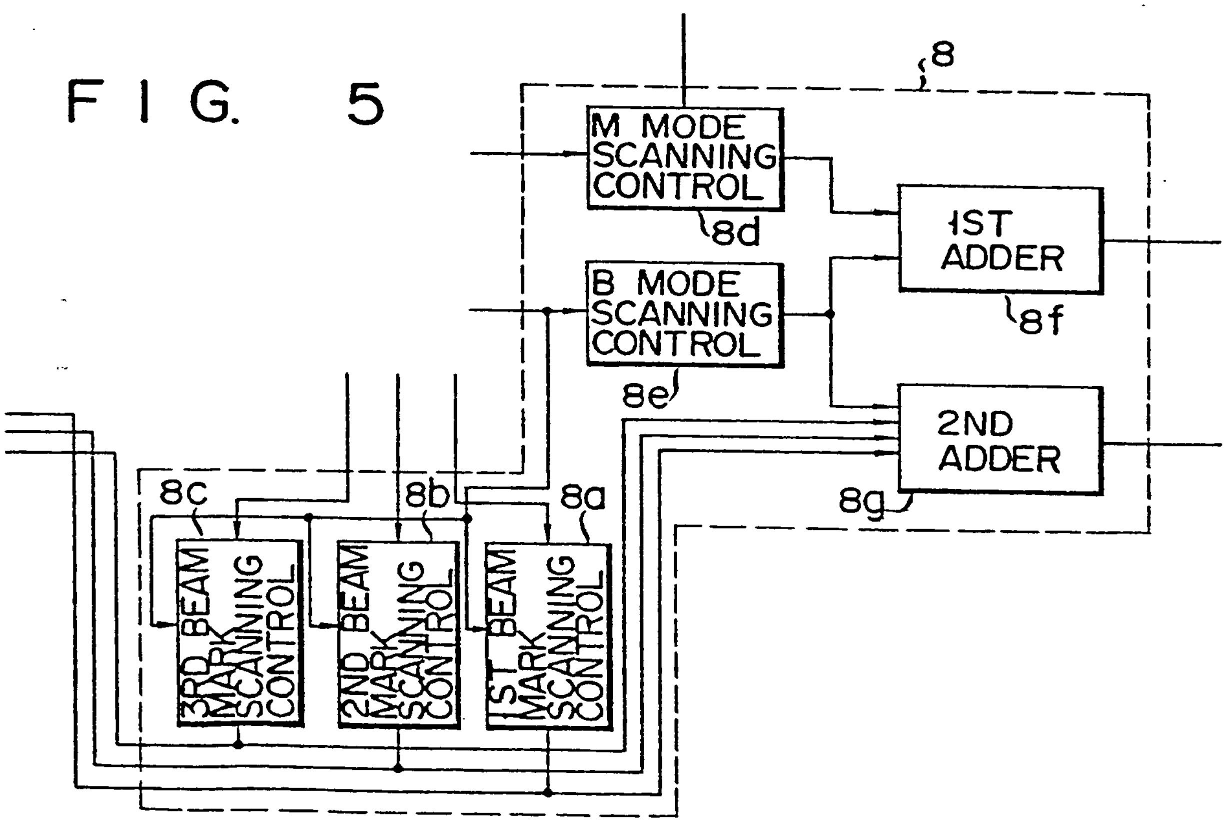
SW1
2
1
3
9
8d
8f
9a
9b
8e
8g
10b
14
8c
8b
8a
10a
8
10d
10c
10e
10
13b
13a
2a
2d
2g
2c
2i
3c
2e
3a
2f
3b

F I G. 4


7
CLOCK PULSE GENERATOR
7a
1ST FREQ. DIV.
7b
1ST GATE
7e
3RD FREQ. DIV.
7d
2ND FREQ. DIV.
7c
2ND GATE
7f

F I G. 5


8
M MODE SCANNING CONTROL
8d
1ST ADDER
8f
B MODE SCANNING CONTROL
8e
2ND ADDER
8g
8c
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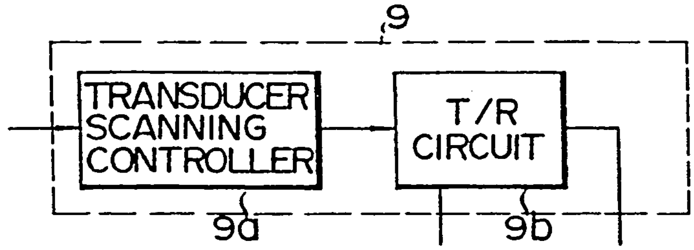
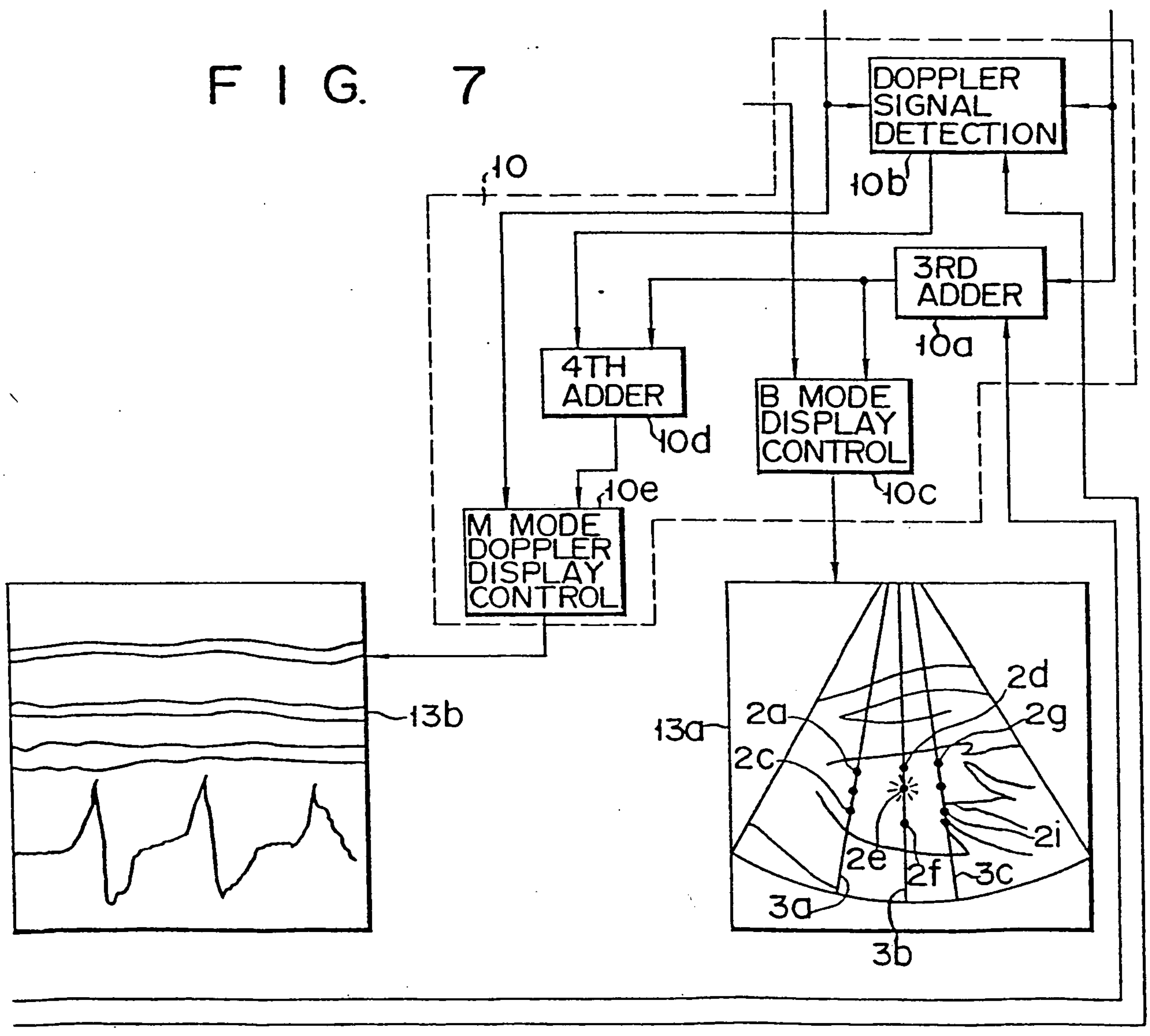
8a
3RD BEAM MARK SCANNING CONTROL
2ND BEAM MARK SCANNING CONTROL
1ST BEAM MARK SCANNING CONTROL

F I G. 6


9
TRANSDUCER SCANNING CONTROLLER
T/R CIRCUIT
9a
9b

F I G. 7


DOPPLER SIGNAL DETECTION
10
10b
3RD ADDER
10a
4TH ADDER
10d
B MODE DISPLAY CONTROL
10c
10e
M MODE DOPPLER DISPLAY CONTROL
13b
13a
2a
2c
2d
2g
2i
2e
2f
3c
3a
3b

6/7

FIG. 8

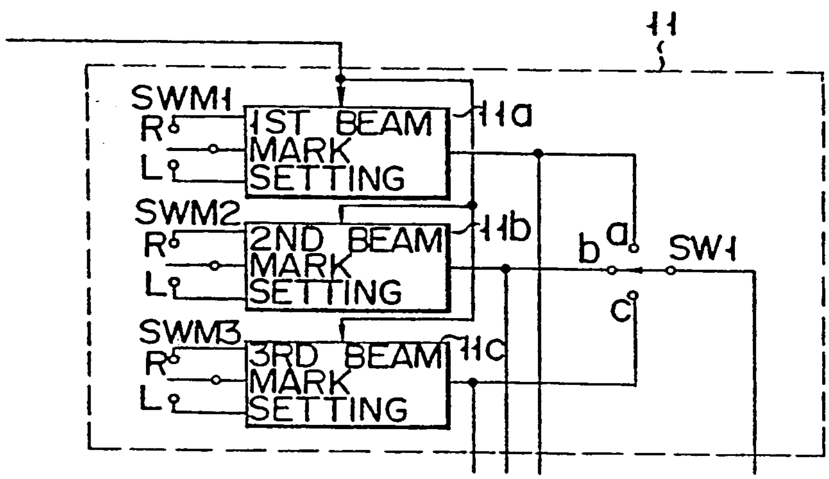
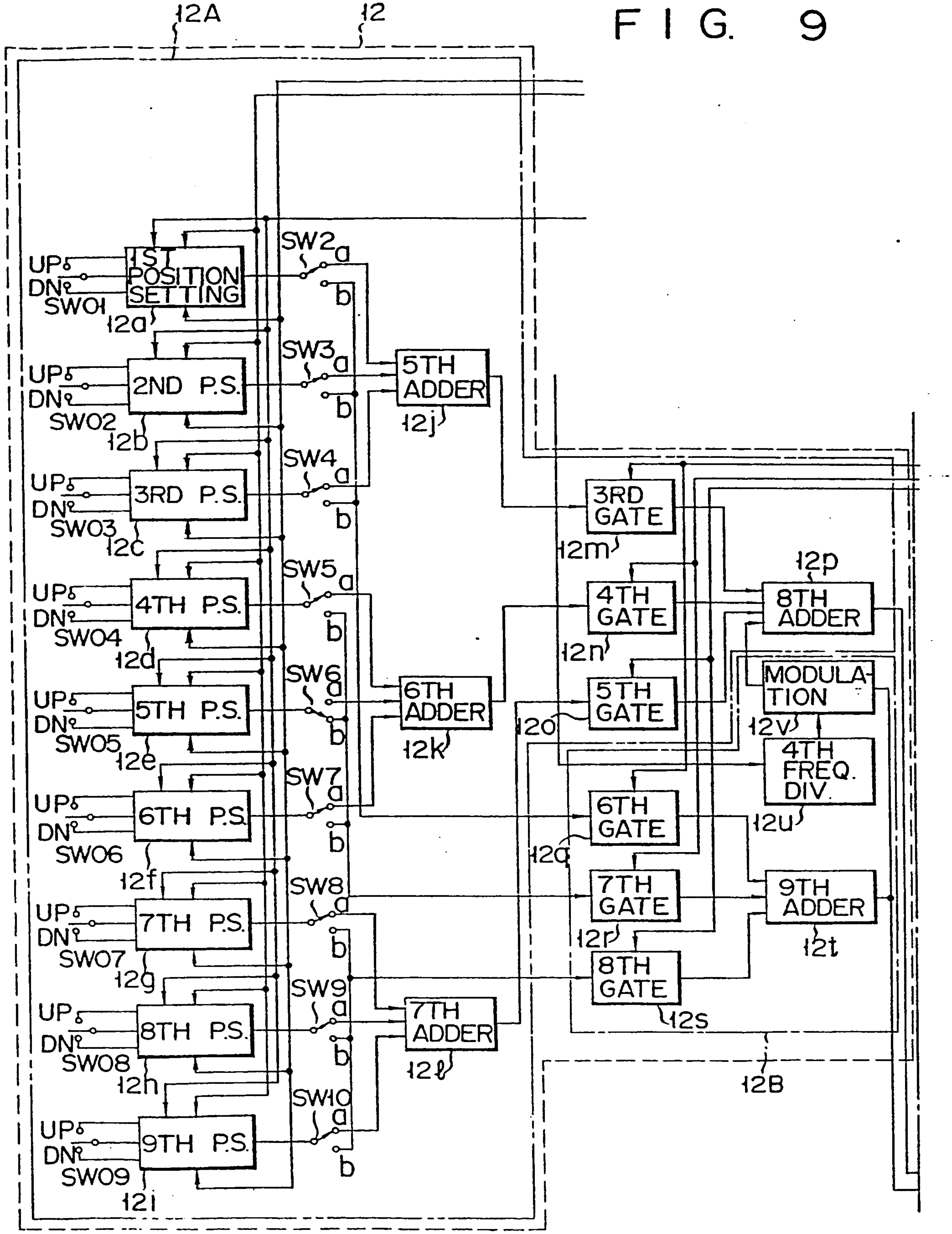

11
SWM1
R
L
1ST BEAM
MARK
SETTING
11a
SWM2
R
L
2ND BEAM
MARK
SETTING
11b
SWM3
R
L
3RD BEAM
MARK
SETTING
11c
a
b
c
SW1

FIG. 9


12A
12
1ST POSITION SETTING
12a
UP
DN
SW01
SW2
a
b
2ND P.S.
12b
SW02
SW3
3RD P.S.
12c
SW03
SW4
4TH P.S.
12d
SW04
SW5
5TH P.S.
12e
SW05
SW6
6TH P.S.
12f
SW06
SW7
7TH P.S.
12g
SW07
SW8
8TH P.S.
12h
SW08
SW9
9TH P.S.
12i
SW09
SW10
5TH ADDER
12j
6TH ADDER
12k
7TH ADDER
12ℓ
3RD GATE
12m
4TH GATE
12n
5TH GATE
12o
6TH GATE
12q
7TH GATE
12r
8TH GATE
12s
8TH ADDER
12p
MODULATION
12v
4TH FREQ. DIV.
12u
9TH ADDER
12t
12B

European Patent Office

EUROPEAN SEARCH REPORT

0079453

Application number

EP 82109070.1

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
A	US - A - 4 141 347 (P.S. GREEN et al.) * Fig. 2-5; claims 1,5-9, 13-17; column 2, line 35 - column 3, line 18; column 5, line 27 - column 6, line 39 *	1,2	A 61 B 10/00 G 01 S 15/00
A	US - A - 4 217 909 (E. PAPADOFRANGAKIS) * Fig. 1; column 4, line 8 - column 6, line 22 *	1,2	
A	EP - A1 - 0 010 304 (TOKYO SHIBAURA) * Fig. 1,2,6; page 6, line 25 - page 7, line 26; page 10, line 26 - page 11, line 31 *	1,2	TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
A	AU - B - 490 105 (THE COMMONWEALTH OF AUSTR.) * Totality *	1,2	A 61 B 10/00 G 01 S 15/00
A	GB - A - 1 404 783 (SIEMENS AG) * Totality *	1,2	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	28-02-1983	LUDWIG

CATEGORY OF CITED DOCUMENTS

- X : particularly relevant if taken alone
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